

TITLE OF THE INVENTION

## DISTANCE MEASUREMENT APPARATUS

BACKGROUND OF THE INVENTIONField of the Invention

5        This invention relates to a distance measurement apparatus  
for transmitting an electromagnetic wave beam such as a laser beam,  
receiving an echo, calculating the time interval between the  
moment of the transmission of the beam and the moment of the  
10    interval, the distance to an object reflecting the beam and causing  
the echo.

Description of the Related Art

      There is a conventional distance measurement apparatus  
mounted on a vehicle. The conventional apparatus intermittently  
15    emits a laser beam into a predetermined angular range outside the  
body of the vehicle. The predetermined angular range is scanned by  
the laser beam. Thus, the predetermined angular range is also  
referred to as the scanned range. When an object in the scanned  
range reflects the laser beam, a portion of the laser beam returns to  
20    the apparatus as an echo. The apparatus measures the time  
difference between the timing of the emission of the laser beam and  
the timing of the reception of the echo. The apparatus calculates  
the distance to the object on the basis of the measured time  
difference. The apparatus recognizes the direction of the emission  
25    of the laser beam which is returned as the echo. The apparatus  
detects the direction of the object relative to the vehicle in

accordance with the recognized direction of the emission of the laser beam.

As the power of the emitted laser beam rises, the measurable distance to an object increases. A laser beam having an excessively  
5 high power adversely affects human eyes when being incident thereto. As a laser diode is driven at a higher power to generate a stronger laser beam, the life of the laser diode shortens.

Japanese patent application publication number 7-134178  
discloses an on-vehicle distance measuring device using a laser  
10 beam which is designed to control the power of the laser beam to perform a proper measurement and avoid a bad effect on human bodies. In the distance measuring device of Japanese application 7-134178, the power of the laser beam is reduced as the distance to a target to be measured decreases. Also, the power of the laser beam  
15 is reduced as the relative speed between the target and the vehicle or the speed of the vehicle decreases. Therefore, the measurable distance to a target is short when the relative speed between the target and the vehicle or the speed of the vehicle is low.

Japanese patent application publication number 9-197045  
20 discloses an on-vehicle radar device using a laser beam which is designed to control the power of the laser beam to avoid a bad effect on human bodies. Operation of the radar device in Japanese application 9-197045 is alternately changed between a preliminary scanning mode and a main scanning mode. During the preliminary  
25 scanning mode of operation, a predetermined angular range outside the body of the vehicle is scanned by the laser beam having a low

power. A memory is loaded with preliminary data representative of laser beam transmission directions and distances to detected targets which are available in the preliminary scanning mode of operation. During the main scanning mode of operation which  
5 follows the preliminary scanning mode of operation, first portions of the predetermined angular range are scanned by the laser beam having a high power while second portions thereof are inhibited from being scanned. Specifically, the preliminary data in the  
10 memory are referred to, and suspension is given of the transmission of the laser beam in the directions in which targets in short distances have been detected during the preliminary scanning mode of operation. On the other hand, the laser beam having a high power is transmitted in the directions from which detected targets have been absent during the preliminary mode of operation.

15 In the radar device in Japanese application 9-197045, there is a timing difference between the preliminary scanning mode of operation and the main scanning mode of operation. During the preliminary scanning mode of operation, the predetermined angular range is fully scanned, and the preliminary data are stored into the  
20 memory. The timing difference, the fully scanning, and the storing of the preliminary data cause a slow response characteristic of the radar device.

Japanese patent application publication number 11-94945 discloses an on-vehicle laser radar device which scans a  
25 predetermined angular range outside the body of the vehicle by a train of pulses of a laser beam. In the radar device of Japanese